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9807-0802

14.0 Bridge Rating

14.1 General

Bridge Rating is a procedure to evaluate the adequacy of various structural components to carry predetermined applied loads. The WSDOT Bridge Preservation Section is responsible for the bridge inventory and load rating of existing and new bridges in accordance with the NBIS and the AASHTO Manual for Condition Evaluation of Bridges, latest edition. As presently required, only elements of the superstructure will be rated. Generally, superstructure shall be defined as all structural elements above the column tops including drop cross-beams.

Load rating shall be part of structural design for all, widened (one lane width or more throughout the length of the bridge), or rehabilitated bridges where the rehabilitation alters the load carrying capacity of the structure. The carrying capacity of a widened or rehabilitated structure shall equal or exceed the capacity of the existing structure. The Bridge Design Section generally will not be required to load rate new bridges/designs. However, for the more complex structures where computer models are used in the design/analysis, a copy of the computer models shall be made and submitted to the Bridge Load Rating Engineer in the Bridge Preservation Section.

In order to provide a baseline rating for new bridges, the bridge designer shall make rating calculations and complete a Bridge Rating Summary (see Appendix 14.0-A5) as part of the design process. The designer shall place the original rating calculations and report and a copy of the bridge plans in an Accopress-type binder (see Section 14.4). When the bridge design is complete, the designer shall forward the completed bridge rating package to the Bridge Projects Unit, then the Bridge Projects Unit will forward the rating package to the Bridge Preservation Section. The bridge rating will go into service at the completion of bridge construction. The Bridge Preservation Section shall then be responsible to maintain an updated bridge load rating throughout the life of the bridge based on current bridge condition (see Appendix 14.0-A1).

Conditions of existing bridges change resulting in the need for reevaluation of their load rating. Such changes may be caused by damage to structural elements, extensive maintenance or rehabilitative work, or any other deterioration identified by the Bridge Preservation Section through their regular inspection program.

This criteria applies only to concrete and steel bridges. For timber bridges, rating procedure shall be as per Chapters 6 and 7 of the 1994 AASHTO *Manual for Condition Evaluation of Bridges*.

14.1.1 Rating Procedure

Structural elements as defined above shall be evaluated for flexural, vertical shear, and torsional capacities based on Load Resistance Factor Design (LRFD) as outlined in the AASHTO 1989 *Guide Specifications for Strength Evaluation of Existing Steel and Concrete Bridges* and Load Factor Design (LFD) as outlined in the 1994 AASHTO *Manual for Condition Evaluation of Bridges*. Consider all reinforcing, including temperature/distribution reinforcing, in the rating analysis.

By definition, the adequacy or inadequacy of a structural element to carry a specified truck load will be indicated by the value of its rating factor (RF); that is, whether it is greater or smaller than 1.0. For a specific loading, the lowest RF value of the structural elements will be the overall rating of the bridge.

14.1.1.1 Load Resistance Factor Rating (LRFR)

For HS-20, AASHTO-1, AASHTO-2, and AASHO-3 trucks, the basic rating equation shall be:

$$\text{R.F.} = (\text{for flexure}) \quad \frac{\phi M_{CAP} - \gamma_D M_{DL} \pm \gamma_P M_P}{\gamma_L M_{(L+I)}}$$

$$\text{R.F.} = (\text{for vertical shear}) \quad \frac{\phi V_{CAP} - \gamma_D V_{DL} \pm \gamma_P V_P}{\gamma_L V_{(L+I)}}$$

For Overload (OL)-1 and Overload-2 trucks, the basic rating equation shall be:

$$\text{R.F.} = (\text{for flexure}) \quad \frac{\phi M_{CAP} - \gamma_D M_D \pm \gamma_P M_P - \left(\gamma_L M_{(L+I)}\right) \text{AASHTO - Truck}}{\left(\gamma_L M_{(L+I)}\right) \text{OL - Truck}}$$

$$\text{R.F.} = (\text{for vertical shear}) \quad \frac{\phi V_{CAP} - \gamma_D V_D \pm \gamma_P V_P - \left(\gamma_L V_{(L+I)}\right) \text{AASHTO - Truck}}{\left(\gamma_L V_{(L+I)}\right) \text{OL - Truck}}$$

Where:

	R.F.	=	Rating Factor (Ratio of Capacity to Demand)
	M_{CAP}	=	Ultimate Bending Moment Capacity
*	M_{DL}	=	Calculated Dead Load Bending Moment
	M_P	=	Secondary Bending Moment Due to Prestressing
*	$M_{(L+I)}$	=	Calculated Live Load and Impact Bending Moment
	f	=	Resistance Factor (Capacity Reduction Factor)
	γ_D	=	Dead Load Factor
	γ_L	=	Live Load Factor
	γ_P	=	Prestress Factor
	I	=	Impact
	V_{CAP}	=	Ultimate Shear Capacity
	V_{DL}	=	Calculated Dead Load Shear Force
	V_P	=	Calculated Prestressing Shear Force
	$V_{(L+I)}$	=	Calculated Live Load Plus Impact Shear Force

*For continuous structures, a one-half support width moment increase is to be used.

14.1.1.2 Load Factor Design Rating (LFDR)

For HS-20 Inventory and HS-20 Operating Ratings, the basic equation shall be:

$$R.F. = \frac{\phi R_n - A_1 D \pm S}{A_2 L\ (1+I)}$$

Where:

R.F.	=	Rating Factor (Ratio of Capacity to Demand)
ϕR_n	=	Nominal Capacity of the Member
D	=	Unfactored Dead Load Moment or Shear
L	=	Unfactored Live Load Moment or Shear
S	=	Unfactored Prestress Secondary Moment or Shear
I	=	Impact Factor to Be Used With the Live Load Effect
A_1	=	Factor for Dead Load (see Section 14.1.4.2)
A_2	=	Factor for Live Load (see section 14.1.4.2)

Additional rating consideration shall be given to prestressed and post-tensioned members and is discussed in further detail in Section 14.2.1.2.

14.1.2 Live Loads

The vehicles specified in the AASHTO *Guide Specifications for Strength Evaluation of Existing Steel and Concrete Bridges* represent legal weights and are to be used to determine posting limits. The two overload vehicles represent extremes in the limits of permitted vehicles in Washington State. The HS-20 vehicle and lane load as specified in the AASHTO *Manual for Condition Evaluation of Bridges* are to be used in reporting the inventory and operating ratings to the National Bridge Inventory.

For the NBI (HS-20 truck or lane) ratings, the number of lanes shall be per AASHTO Specification 3.6). For WSDOT ratings (legal and overloads), the number of lanes shall be the actual striped lanes at the time of rating.

When multiple lanes are considered, apply the appropriate multilane reduction factor given in Section 14.1.7. Load distribution methods are discussed under specific bridge types. Do not consider sidewalk live loads in rating analysis.

14.1.2.1 Load Resistance Factor Rating (LRFR)

The six moving loads for the initial rating shall be the HS-20 truck loading (Figure 14.1.2-4), three AASHTO vehicles and two overload trucks (Figure 14.1.2-1). In addition, use the lane loading as shown on Figure 14.1.2-2 to rate structures with spans over 200 feet. For the two overload trucks (OL-1 and OL-2), use only one overload truck occupying one lane in combination with one of the AASHTO trucks in each of the remaining lanes.

14.1.2.2 Load Factor Design Rating (LFDR) for National Bridge Inventory (NBI)

The live load to be used in the basic rating equation should be the HS-20 truck (Figure 14.1.2-4) or lane loading (Figure 14.1.2-3) as defined in the AASHTO *Design Specifications.* Where the effects are greater than those produced by HS-20 truck, the bridge should also be rated using the lane loading.

14.1.3 Dead Loads

Dead Loads shall be as defined in the AASHTO *Standard Specifications for Highway Bridges*, except for concrete weight shall be 155 pcf. Dead Load shall include weight of any existing bridge deck overlay. When overlay depth is not known, allowance shall be as per Section 3.3.2.1 of the AASHTO *Guide Specifications*.

14.1.4 Load Factors

14.1.4.1 Load Resistance Factor Rating (LRFR)

Dead Load $\gamma D = 1.20$

Prestress Load $\gamma P = 1.00$

Live Load*

1. Low volume roadways (ADTT less than 1,000), significant sources of over weight trucks without effective enforcement. $\gamma L = 1.65$
2. Heavy volume roadways (ADTT greater than 1,000), significant sources of over weight trucks without effective enforcement. $\gamma L = 1.80$
3. OL-1 and OL-2 (or other permit vehicles). $\gamma L = 1.30$

**Notes:*

If unavailable from traffic data, ADTT may be estimated as 20 percent of ADT.

The listed factors are essentially the same as Table 2 of AASHTO *Guide Specifications* except that Live Load Category 1 and 2 have been eliminated based on the assumption that Washington State does not have fully effective enforcement or control of overloads.

Trucks for Rating (for LRFR)

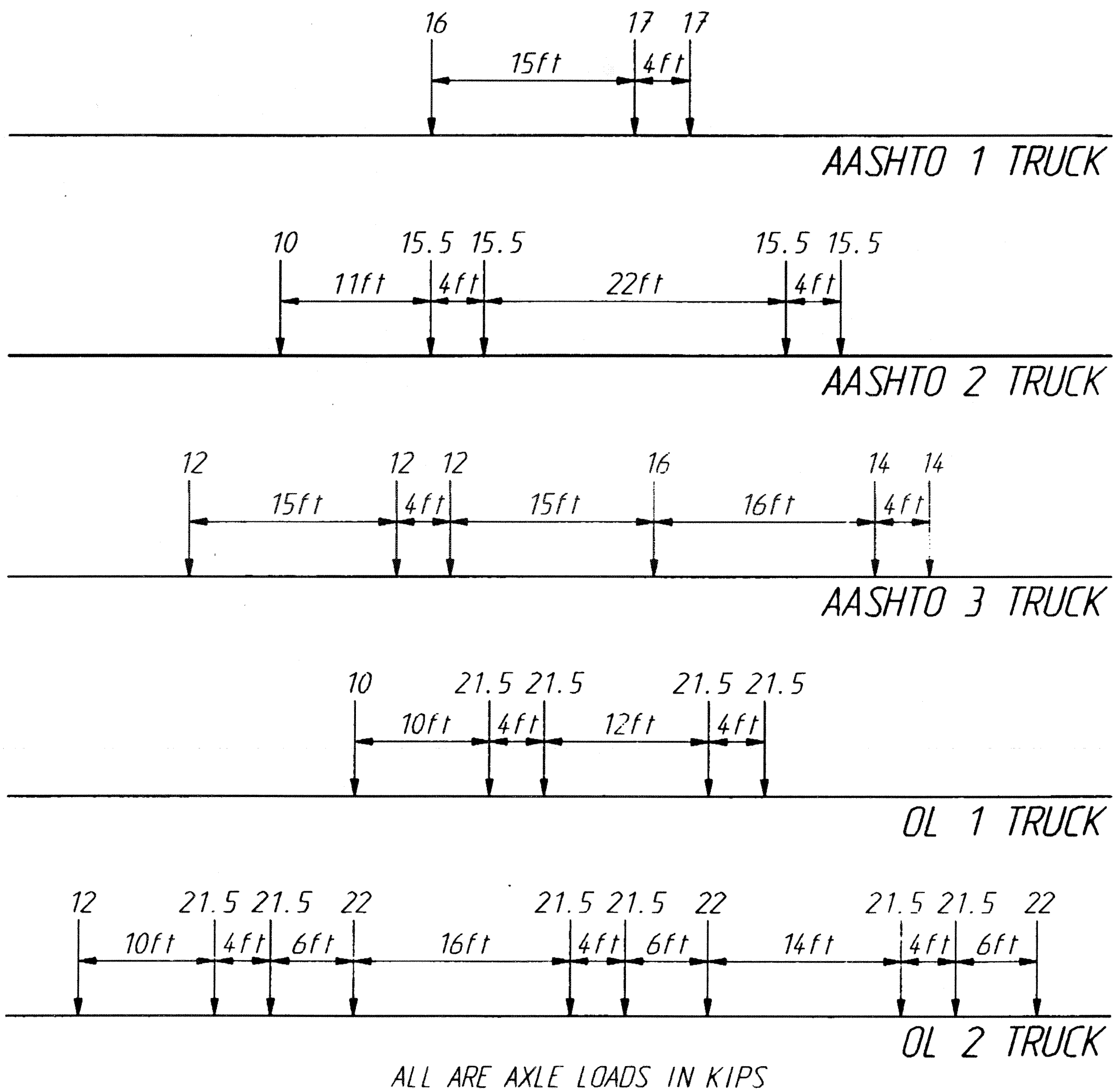

Figure 14.1.2-1

Lane Load Rating (for LRFR)

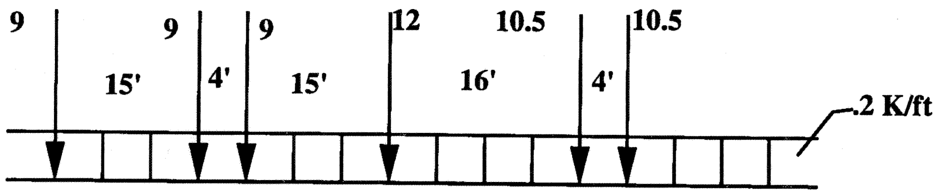

Figure 14.1.2-2

Lane Load Rating (for LFDR)

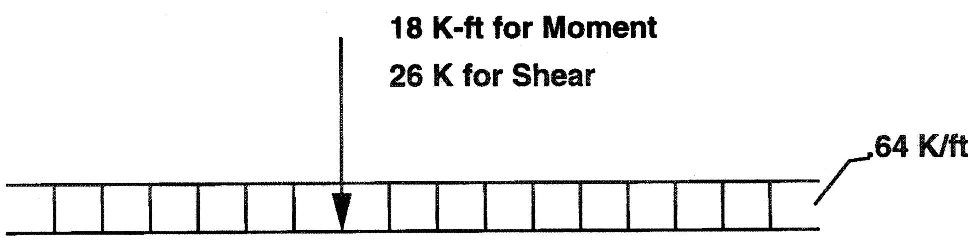

Figure 14.1.2-3

HS-20 Truck (for both LRFR and LFDR)

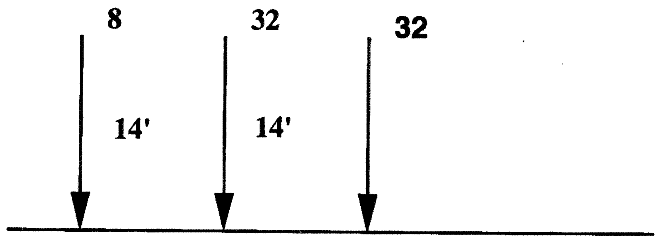

Figure 14.1.2-4

14.1.4.2 Load Factor Design Rating (LFDR)

Dead Load		$A_1 = 1.30$
Live Load	Operating	$A_2 = 1.30$
	Inventory	$A_2 = 2.17$

14.1.5 Load Capacity Reduction Factors

14.1.5.1 Load Resistance Factor Rating (LRFR)

The resistance factors shall be per Table 3b or Figure 4 of the 1989 AASHTO Guide Specifications for Strength Evaluation of Existing Steel and Concrete Bridges. Questions regarding interpretation of the table or figure should be directed to the Bridge Load Rating Engineer. The resistance factors can be increased up to a maximum of 0.95, or decreased, depending on the condition, redundancy, type of inspection, and type of maintenance. For state owned bridges, assume careful inspection and vigorous maintenance and for local agency bridges, consult with the agency's Bridge Engineer.

Following are the NBI and BMS condition codes and their interpretation:

For NBI Codes > or = 6 (BMS States 1 and 2) — no deterioration
For NBI Codes = 5 (BMS State 3) — some deterioration
For NBI Codes < 5 (BMS State 4) — heavy deterioration

The BMS coding shall be used to identify the conditions of the elements being rated, and the appropriate resistance factors shall be applied.

When rating members that have section loss identified in the inspection report, the members should be modeled using the reduction section. Then, use the resistance factors for members in satisfactory condition.

14.1.5.2 Load Factor Rating (LFDR)

The resistance factors for NBI ratings shall be per the latest AASHTO Standard Specifications. Following are the NBI resistance factors:

Steel Members:	1.00 (Flexure)
	1.00 (Shear)
Prestressed Concrete:	1.00 (Flexure)
	0.90 (Shear)
Post-tensioned, Cast in place:	0.95 (Flexure)
	0.90 (Shear)
Reinforced Concrete:	0.90 (Flexure)
	0.85 (Shear)

14.1.6 Impact

14.1.6.1 Load Resistance Factor Rating (LRFR)

For new designs, impact shall be 10 percent (0.1).

For existing bridges, the impact shall be determined by the approach roadway and the deck condition. For approach roadway condition codes 6 or greater, assume 10 percent impact; for codes less than 6, assume 20 percent impact. If the bridge deck condition is 6 or greater or has 0 to 4 percent scaling, assume 10 percent impact; if the deck condition is 5 or has between 5 and 15 percent scaling, assume 20 percent impact; if the deck condition is 4 or less and has greater than 15 percent scaling, assume 30 percent impact.

14.1.6.2 Load Factor Rating (LFDR)

Impact is expressed as a fraction of the live load stress, and shall be determined by the following formula:

$$*I = \frac{50}{L + 125}$$

Where:

I = Impact Fraction (maximum 30%)

L = Length in Feet of the Portion of the Span That is Loaded to Produce the Maximum Stress in the Member.

*AASHTO Standard Specifications for Highway Bridges 3.8.2.1.

14.1.7 Reduction Factors (for both LRFR and LFDR)

Number of Loaded Lanes	*Reduction Factor*
One or two lanes	1.0
Three lanes	0.8
Four lanes or more	0.7

14.1.8 Ratings for Overloads (LRFR)

The OL-1 and OL-2 truck loads listed in Section 14.1.2 are considered to be overloads.

Due to the infrequent nature of the overloads, it is more reasonable to use reduced live load factors for rating rather than those specified for design. For special cases, such as checking prestressed concrete members by the service load method, the rating factors should be established by using higher allowable stresses (see Section 14.2, Special Rating Criteria).

For overload ratings, the load factors to be used in the basic rating equation shall be:

$\gamma_D = 1.2$

$\gamma_L = 1.3$

$\gamma_P = 1.0$

14.2 Special Rating Criteria

14.2.1 Prestressed Concrete Bridges

14.2.1.1 Load Resistance Factor Rating (LRFR)

For prestressed concrete members, rating is to be determined by the service and strength load methods for bending moments.* The lowest rating of either method shall govern.

For prestressed girders designed for continuous of live load and impact, rate the negative moment zone at interior supports as a conventional reinforced concrete member, considering only the deck reinforcement (by load factor method). For loading conditions that produce positive moment at the supports, the prestressed girders extended strands can be considered as positive reinforcement.

Rating for shear in the girder shall begin at a distance $^{h}/2$ from the centerline of the pier (h = overall girder depth).

When rating for AASHTO vehicles, allowable stresses shall be:

Tensile stress for top and bottom = $6(f'_c)^{1/2}$

Compressive stress = $0.4\ f'_c$

When rating for overload trucks (OL-1 and OL-2), allowable stresses shall be:

Tensile stress for top and bottom = $1.15\ [6(f'_c)^{1/2}]$

Compressive stress = $0.53\ (1.3\ f'_c)$

For all loadings, prestress losses shall be as per design or current AASHTO *Design Specifications*.

*When the bending moment rating for the overload vehicles is less than 1.0, a check by the ultimate load method shall also be made. The rating recorded on the summary sheet shall be the value determined by the ultimate load method divided by 1.30 but no greater than 1.0.

14.2.1.2 Load Factor Design (LFD)

The rating of prestressed concrete members at both Inventory and Operating level should be established in accordance with the strength requirements of Article 9.17 of the *AASHTO Design Specifications*. Additionally at Inventory level, the rating must consider the allowable stresses at service load as specified in Article 9.15.2.2 of the AASHTO *Design Specifications*. In situations of unusual design with wide dispersion of the tendons, the operating rating might further be controlled by stresses not to exceed 0.90 of the yield point stresses in the prestressing steel nearest the extreme tendon fiber of the member.

Typically, prestressed concrete members used in bridge structures will meet the minimum reinforcement requirements of Article 9.18.2.1 of the AASHTO *Design Specifications*. While there is no reduction in the flexural strength of the member and, in the event that these provisions are not satisfied, the Bridge and Structures office, may choose, as part of the flexural rating, to limit live loads to preserve the relationship between ϕM_n and $1.2M_{cr}$ that is prescribed for a new design. The use of this option necessitates an adjustment to the value of the nominal moment capacity ϕM_n, used in the flexural strength rating equations. Thus when $\phi M_n < 1.2M_{cr}$, the nominal moment capacity becomes $(k)\phi(Mn)$,

$$k = \frac{\phi M_n}{1.2M_{cr}}$$

Inventory Rating

To establish the Inventory rating for Prestressed Concrete, use the lowest rating factor from the basic rating equation, shown in Section 14.1.1.2, and the following equations:

R.F. = (Concrete Tension) $$\frac{6\,(f'_c)^{1/2} - F_d + F_p \pm F_s}{F_l}$$

R.F. = (Concrete Compression) $$\frac{0.6f'_c - F_d - F_p \pm F_s}{F_l}$$

R.F. = (Concrete Compression) $$\frac{0.4f'_c - \frac{1}{2}\left(F_d - F_p \pm F_s\right)}{F_l}$$

R.F. = (Prestressing Steel Tension) $$\frac{0.8f{*}y - \left(F_d + F_p \pm F_s\right)}{F_l}$$

Operating Rating

To establish the operating rating for Prestressed Concrete, use the lowest rating factor, from the basic rating equation, shown in Section 14.1.1.2, and the following equation should be used:

R.F. = (Prestressing Steel Tension) $$\frac{0.9f{*}y - \left(F_d + F_p \pm F_s\right)}{F_l}$$

Where:

R.F.	=	Rating Factor (Ratio of Capacity to Demand)
f'_c	=	Concrete Compressive Strength
F_d	=	Unfactored Dead Load Stress
F_p	=	Unfactored Stress Due to Prestress Forces After All Losses
F_s	=	Unfactored Stress Due to Secondary Prestress Forces
F_l	=	Unfactored Live Load Stress Including Impact
f*y	=	Prestress Steel Yield Stress (per AASHTO 9.1.2)

14.2.2 Reinforced Concrete Structures

For conventional reinforced concrete members of existing bridges, checking of serviceability shall not be part of the rating evaluation.

Rating for shear in the longitudinal direction shall begin at a distance $^h/2$ from the centerline of the pier (h = total depth).

14.2.2.1 Concrete Decks

For all concrete bridge decks, except flat slab bridges, that are designed per current AASHTO criteria for HS-20 loading or heavier, loading will be considered structurally sufficient and need not be rated. However, for existing bridge decks having any of the following conditions, rating will be required:

1. Deck was designed for live loads lighter than HS-20.
2. Deck overhang is more than half the girder spacing.
3. Bridge Inspection Report Code is below 4.
4. When the original traffic barrier(s) or rail have been replaced by heavier barrier.

When rating of the deck is required, live load shall include all vehicular loads as specified in Section 14.1.2 and load distribution shall be per current AASHTO *Standard Specifications for Highway Bridges* for the HS20 truck and per AASHTO Manual for Maintenance Inspection of Bridges for legal and overload trucks.

14.2.2.2 Concrete Crossbeams

Live loads can be applied to the crossbeam as moving point loads at any location between curbs which produce the maximum effect.

When rating for shear in crossbeams, current AASHTO *Design Specifications* requires shear design to be at the face of support if there is a concentrated load within a distance "d" from the face of support. This requirement is new relative to earlier editions of AASHTO *Design Specifications* which allowed shear reinforcement design to be at a distance "d" from the face of support. When rating existing crossbeams which show no indication of distress on the latest inspection report, but have a rating factor of less than one (1.0), a more detailed/accurate shear analysis should be performed. One acceptable method is the "truss analogy" as published in Bibliography 14.99-1(1). For existing box girder and integral T-beam crossbeams, in lieu of this detailed analysis, dead and live loads can be assumed as uniformly distributed and the shear rating performed at a distance "d" from the face of support.

14.2.2.3 In-Span Hinges

For in-span hinges, rating for shear and bending moment should be performed based on the reduced cross-sections at the hinge seat. Diagonal hairpin bars are part of this rating as they provide primary reinforcement through the shear plane.

14.2.3 Concrete Box Girder Structures

Bridges with multi-cell separate box girdrs shall be rated on a per box basis. Otherwise, the rating shall be on the per bridge basis for all applied loads. This is consistent with the current design procedures regarding live load applications.

14.2.4 Concrete T-Beam Structures

Rate on a per member basis, except for precast girder units, which are to be rated per unit.

14.2.5 Concrete Flat Slab Structures

Rate cast-in-place solid slabs on a per foot of width basis. Rate precast panels on a per panel basis. Rate cast-in-place voided slabs based on a width of slab equal to the predominant center-to-center spacing of voids.

Load distribution shall be per current AASHTO *Standard Specifications for Highway Bridges*.

When rating flat slabs on concrete piling, assume pin-supports at the slab/pile interface of interior piers and the slab continuous over the supports. If ratings using this assumption are less than 1.0, the piles should be modeled as columns with fixity assumed at 10 feet below the ground surface.

Pile caps are to be rated if deemed critical by the engineer.

14.2.6 Steel Structures

On existing bridges, checking of fatigue and servicability shall not be part of the rating evaluation.

14.2.6.1 Steel Floor Systems

Floorbeams and stringers shall be rated as if they are simply supported. Assume the distance from outside face to outside face of end connections as the lengths for the analysis. For steel floorbeams on new bridges, rate for the number of designated lanes (see 14.1.2). For existing structures, rate for the number of striped lanes. Live loads conforming to these lane configurations can be applied to the floorbeam as moving point loads at any location between curbs which produce the maximum effect.

The end connections for stringers and floorbeams shall be rated.

Do not rate connections unless there is evidence of deterioration.

14.2.6.2 Steel Truss Structures

The capacity of steel truss spans, regardless of length, shall follow the AASHTO Gu*ide Specifications for Strength Design of Truss Bridges* (load factor design) and the AASHTO *Standard Design Specifications*. In the event the two specifications are contradictory, the guide specification is to be followed.

Rate on a per truss basis using either 3-D analysis or simplified distribution methods. Assume nonredundancy of truss members and pinned connections.

In general, rate chords, diagonals, verticals, end posts, stringers, and floorbeams. Do not rate connections unless there is evidence of deterioration, except for pinned connections with trusses. For pin-connected trusses, also analyze pins for shear, and the side plates for bearing capacity.

For truss members that have been heat-straightened three or more times, deduct 0.1 from ϕ(Phi).

14.2.7 Timber Structures

Unless the species and grade is known, assume Douglas fir, select structural for members installed prior to 1955 and Douglas fir, No. 1 after 1955. The allowable stresses for beams and stringers, as listed in the AASHTO *Standard Design Specifications*, should be used.

The inventory rating for HS-20 vehicle is calculated using allowable stresses as directed in the AASHTO *Standard Design Specifications*. For calculating the operating rating for the HS-20 vehicle, the 3 AASHTO, and two overload vehicles, use 133 percent of the inventory allowable stress.

The nominal dimensions should be used to calculate deadload, and the net dimensions to calculate section modulus. If the member is charred, it may be assumed the $^1/_4$-inch of material is lost on all surfaces. Unless the member is notched or otherwise suspect, shear need not be calculated.

When calculating loads, no impact is assumed and distribution factors are selected assuming one traffic lane where the roadway is less than 20 feet wide or two or more traffic lanes where the roadway is 20 feet or wider.

14.2.8 Widened or Rehabilitated Structures

For widened bridges, rate crossbeams in all cases.

Since the longitudinal capacity of the widened portion of the structure will equal or exceed the capacity of the existing structure, a longitudinal rating for the widened portion will be required only when the width of the widened portion on one side of the structure is greater than or equal to 12′-0″ or more throughout the length of the structure.

For rehabilitated bridges, a load rating will be required if the load carrying capacity of the structure is altered by the rehabilitation.

14.2.9 Other Special Cases

For nonredundant structures such as through girder, arches, and/or any superstructure with less than three main load carrying members, rating shall be on the per member basis.

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14.3 Load Rating Software

Use the current version of BRIDG for Windows software for all applicable ratings. The capabilities and release dates of the BRIDG software are as follows:

Release Version	*Release Date*	*Rating Capabilities*
BRIDG v.10.6.	August 1999	LRFD and LF of concrete bridges.
BRIDG v.11.0.	November 1998	LRFD and LF of steel girder bridges.
BRIDG v.97	July 2000	LRFD and LF of steel girder and steel truss bridges.

*Tenative release dates.

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14.4 Load Rating Reports

Rating reports shall consist of:

1. A Bridge Rating summary sheet as shown on Appendix 14.0-A5 reflecting the lowest rating factor, including superstructure components not analyzed by BRIDG, for each loading condition. The summary sheet shall be stamped and signed by a licensed professional engineer in the state of Washington.
2. A brief report of any anomalies in the ratings and an explanation of the cause of any rating factor below 1.0.
3. Hard copy of computer output files (RPT files) used for rating, and any other calculations or special analysis required.
4. A complete set of plans for the bridge.
5. One 3.5-inch data diskettes or compact disk which contains the final versions of all input and output files, and other calculations created in performing the load rating.

All reports shall be bound in Accopress-type binders.

When the load rating calculations are produced as part of a design project (new, widening, or rehabilitation,) the load rating report and design calculations shall be bound separately.

Any questions on the BRIDG Program or load rating can be directed to the bridge Load Rating Engineer.

14.99 Bibliography

1. Manual for Condition Evaluation of Bridges (1994) AASHTO, 444 North Capitol Street NW, Suite 249, Washington, D.C. 20001.

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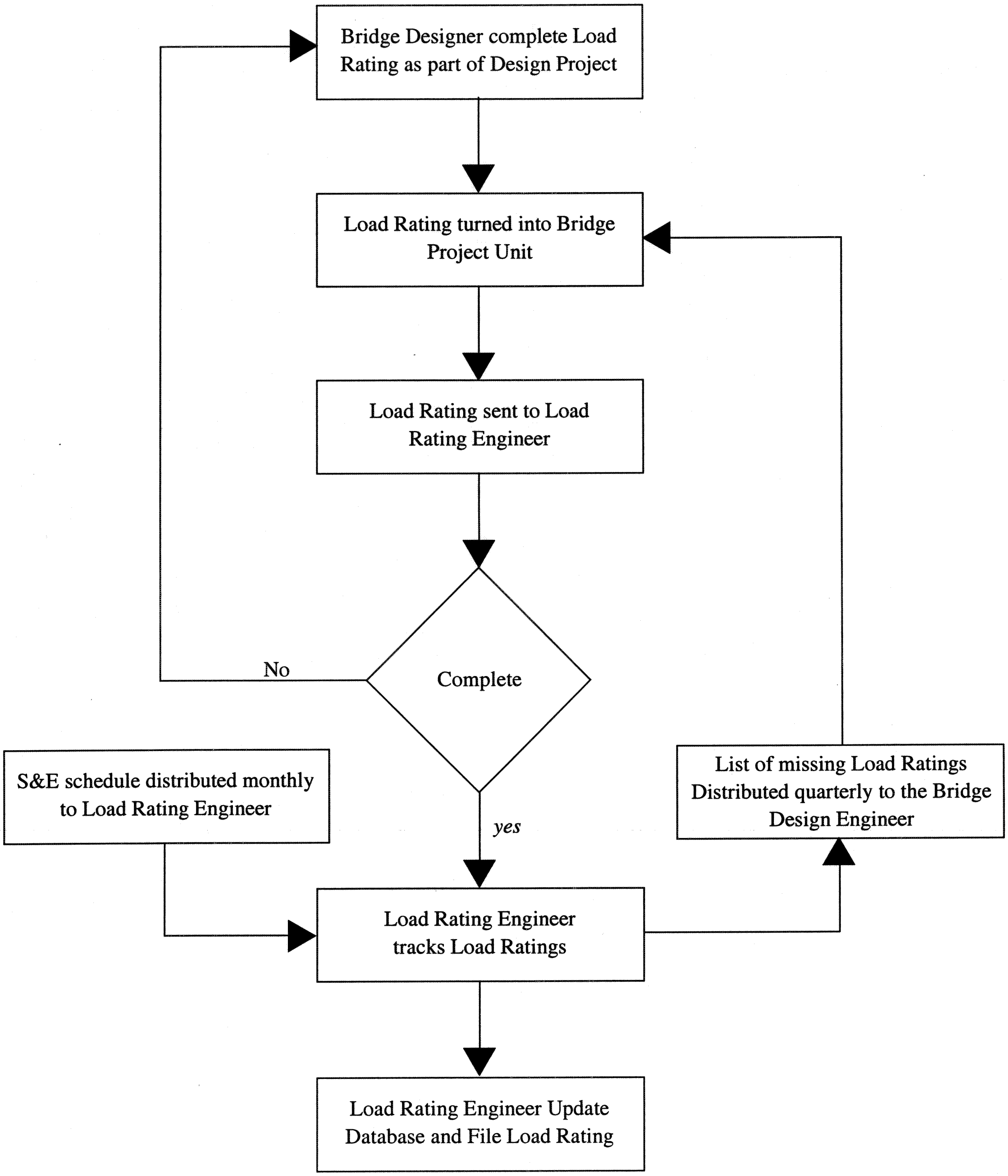
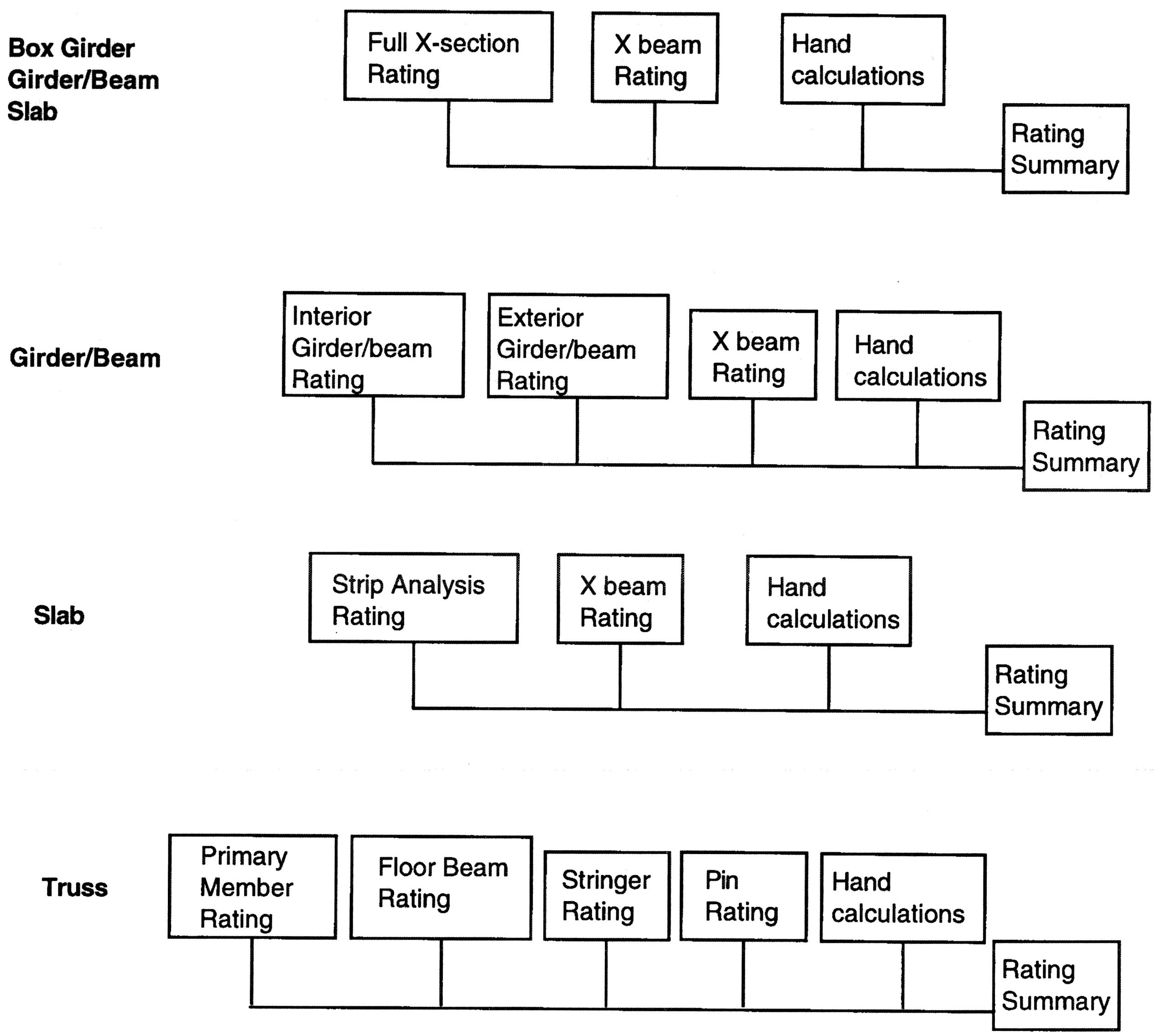

Bridge Designer complete Load Rating as part of Design Project
Load Rating turned into Bridge Project Unit
Load Rating sent to Load Rating Engineer
Complete
No
yes
S&E schedule distributed monthly to Load Rating Engineer
List of missing Load Ratings Distributed quarterly to the Bridge Design Engineer
Load Rating Engineer tracks Load Ratings
Load Rating Engineer Update Database and File Load Rating

Source of Rating Factors

Bridge Type



The Rating Summary reflects the lowest rating factor for each truck from the rating sources.

Bridge Inspection Report Condition Codes

9 Not applicable.

8 Very good condition. No defects. Bridge can carry normal traffic levels. No action required to monitor or repair.

7 Good condition. Minor defects with potential for minor repair. Bridge can carry normal traffic levels. Record and monitor bridge conditions.

6 Satisfactory condition. Moderate defects with potential for major repair. Bridge is adequate for normal traffic levels. Record and monitor bridge conditions and/or add to repair schedule.

5 Fair condition. Moderate defects with potential for minor rehabilitation. Bridge is minimally adequate for highway traffic. Monitor bridge conditions and/or add to repair schedule.

4 Poor Condition. Major defects requiring major repair. Bridge is marginally adequate for truck traffic. Make repairs as soon as possible.

3* Serious condition. Major defects. Member is failing. Bridge is inadequate for truck traffic. Repair bridge immediately or restrict truck traffic.

2* Critical condition. Major defects. Member has failed. Bridge is inadequate for all highway traffic. Repair bridge immediately or close bridge.

1* Imminent failure. Bridge is closed and inadequate for all highway traffic. Bridge cannot be rehabilitated.

0* Failed. Bridge is closed and inadequate for all highway traffic. Bridge is beyond repair.

*These codes are used to rate the condition of primary bridge members only (i.e., trusses, beams, abutments, etc.).

For changing values in the rating factor equation, a condition code of 7 or 8 corresponds to good or fair condition. A condition code of 5 or 6 corresponds to a deteriorated condition; generally the report would identify the deficient structural elements with specifics such as section loss.

A condition code of 4 or less corresponds to a heavily deteriorated condition. The report should state the specific element with its section loss.

Inspection is considered to be estimated except in a specific case associated with identifiable deteriorated and/or deteriorating structures.

Maintenance is considered intermittent unless specifically directed in unusual circumstances.

Span Type Abbreviations

BAS	Bascule Lift Span	SA	Steel Arch
CA	Concrete Arch	SB	Steel Beam
CBOX	Concrete Box Girder	SBOX	Steel Box Girder
CFP	Concrete Floating Pontoon	SCULV	Steel Culvert
CG	Concrete Girder	SFP	Steel Floating Pontoon
CS	Concrete Slab	SG	Steel Girder
CST	Concrete Slab on Timber Piling	SL	Steel Lift Span
CTB	Concrete T-Beam	SS	Steel Swing Span
CTRU	Concrete Truss	ST	Steel Truss
CTUN	Concrete Lined Tunnel	SUSP	Steel Suspension Span
CCULV	Concrete Culvert	TCULV	Timber Culvert
ESB	Encased Steel Beam	TTLB	Treated Timber Laminated Beam
PCB	Pretensioned Concrete Beam	TTLL	Treated Timber Longitudinal Laminated
PCS	Pretensioned Concrete Slab	TTRU	Treated Timber Truss
PCTB	Pretensioned Concrete T-Beam	TTS	Salts-Treated Timber Trestle
POB	Post-tensioned Concrete Beam	TTT	Creosote-Treated Timber Trestle
POTB	Post-tensioned Concrete T-Beam	TTUN	Timber-Lined Tunnel
PTBX	Post-tensioned Box Girder	TUN	Tunnel
PRC	Precast Reinforced Concrete Beam	UTL	Untreated Log
PRPOB	Pretensioned and Post-tensioned Beam	UTRU	Untreated Timber Truss
		UTT	Untreated Timber Trestle
		UTLB	Untreated Timber Laminated Beam

PE Stamp Here

BRIDGE RATING SUMMARY

Bridge Name: ______________________________
Bridge Number: ______________________________
Span Types: ______________________________
Bridge Length: ______________________________
Design Load: ______________________________
Rating By: ______________________________
Checked By: ______________________________
Date: ______________________________

Truck	RF	γ	Controlling Point
HS-20			
AASHTO 1			
AASHTO 2			
AASHTO 3			
OL-1			
OL-2			

NBI Rating	RF	Tons (US)	Controlling Point
Inventory			
Operations			

Remarks:

3D Live Load Modeling Guidelines for Truss Bridges

Live Load Criteria

The live loads to be considered and the application thereof, shall be consistent with those described in the AASHTO *Guide Specifications for Strength Evaluation of Existing Steel and concrete Bridges* and the WSDOT *Bridge Design Manual.* To summarize the criteria:

- In computing load effects, one vehicle shall be considered present in each rating lane.
- The positioning of the vehicle in each rating lane shall be according to AASHTO specifications. These specifications require the vehicle to be positioned in such a way as to produce the extreme structural response under consideration.
- For the purpose of load rating, the number of rating lanes shall be considered the number of striped lanes.
- The rating lanes shall be positioned between the curbs in accordance with the AASHTO specifications.

Live Load Modeling Guidelines

The purpose of these guidelines is to provide the rating engineer with a live load modeling scheme that will capture the significant load effects for typical, well conditioned truss bridges, while reducing the time required to perform a detailed live load analysis. Typical truss bridges are symmetrical about their longitudinal axes, with parallel trusses, straight members, and uniform spacing of floor beams. It is ultimately the responsibility of the rating engineer to determine the minimum rating factor for the structure. For unique and/or poorly conditioned structures, this may require a more detailed evaluation of the live load effects.

BRIDG™ for Windows® implements a brute force live load analysis method. To improve live load analysis performance, the generation of live load cases must be reduced. These guidelines describe live load generation in terms of longitudinal step sizes for the movement of the trucks along the bridge and transverse lane positions between the curb lines.

Minimum Longitudinal Step Size

Longitudinal step shall not be less than the distance between floor beams.

Transverse Placement of Rating Lanes

The transverse placement of rating lanes is guided by the Lane Shift Sensitivity Factor (LSSF). This factor is used to determine if the response of the structure is sensitive to lane positioning. The Lane Shift Sensitivity Factor is computed by:

LSSF = (# of Design Lens - # of Rating Lanes) / # of Rating Lanes

Where:

Number of rating Lanes is the equal to the number of lanes currently striped on the bridge.

Number of Design Lanes is as specified by the AASHTO Standard Specification for Bridges.

The position of rating lanes is described in the following table:

Sensitivity	LSSF	Lane Group Positioning
Insensitive	LSSF < 0.25	Center of the bridge
Sensitive	$0.25 \leq LSSF \leq 1.0$	Left Edge, Center, Right Edge
Hypersensitive	LSSF > 1.0	Left Edge, Left Quarter Point, Center, Right Quarter Point, Right Edge

This method of transverse placement will be used to determine the Inventory and Operating Ratings for reporting to the National Bridge Inventory. This method will also be used to determine if the bridge needs further investigation by the WSDOT Bridge Preservation office. This investigation will determine the need for posting, restriction to permit (a.k.a. overload) vehicles, and need for retrofit or rehabilitation.

P65:DP/BDM